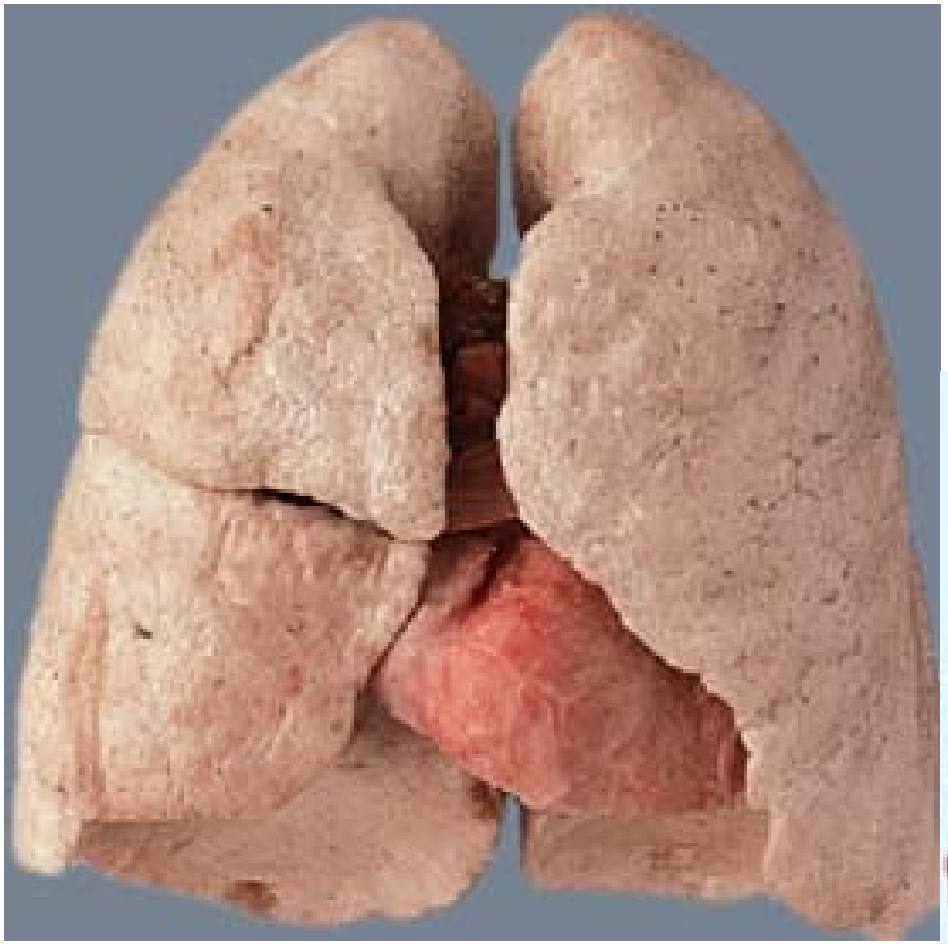
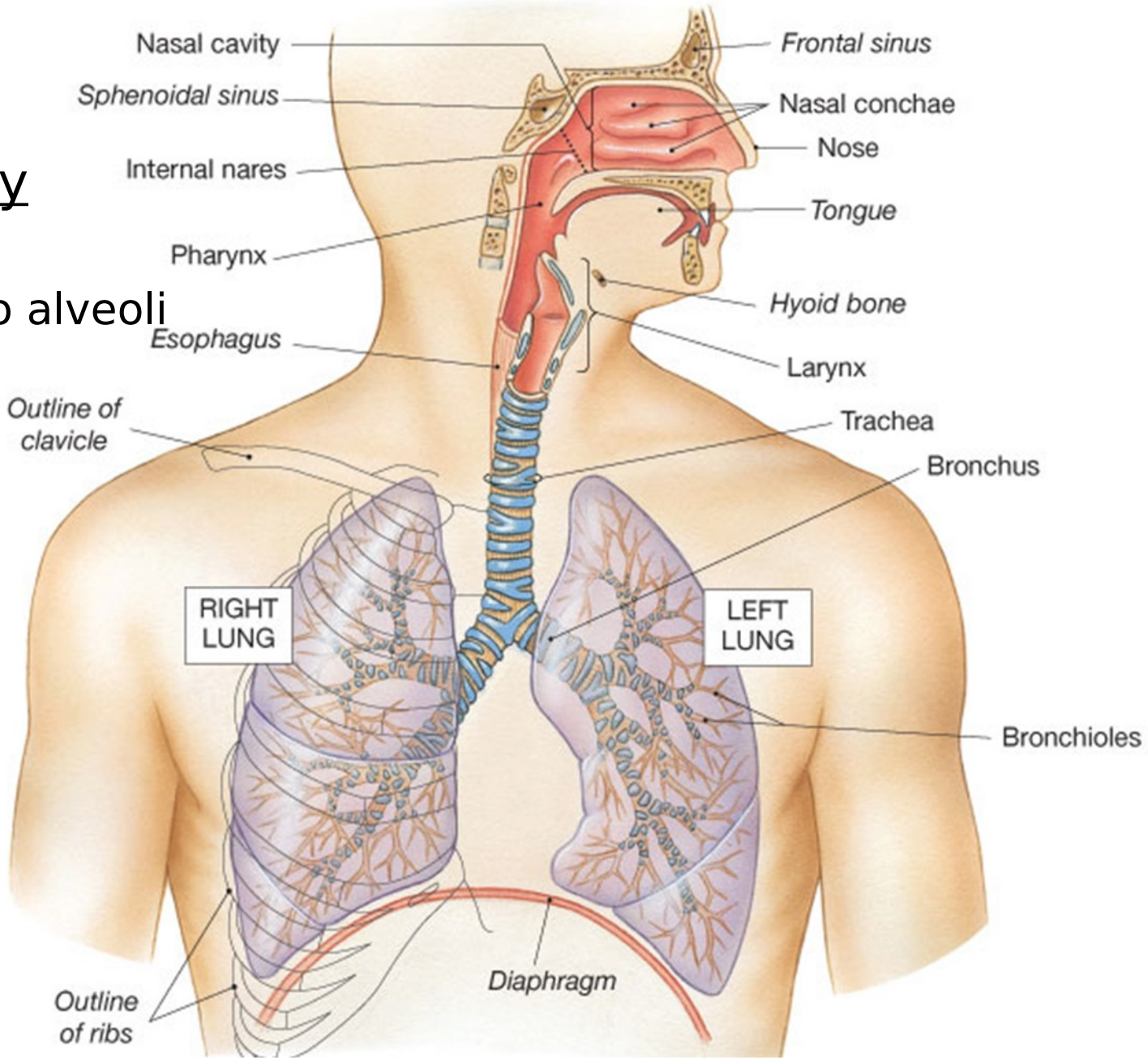


nctions of Respiratory Syster

- Ventilation - moves air to and from alveoli.
- Provides large surface area for gas exchange.
- Regulates pH of body fluids.
- Permit vocal sounds (communication).

Respiratory Tract:

From nose to alveoli



- **Upper Respiratory Tract**
  - Nose
  - Nasal cavity
  - Pharynx (3 parts)

Functions: Conditions inspired air
Warms, Filters and Humidifies incoming air.

- **Lower Respiratory Tract**

- Larynx
- Trachea
- Bronchi
- Bronchioles
- Alveoli

Functions:
Conducts air and exchange gases.

Respiratory Tract (Passageway)

External nares > vestibule of nose > nasal cavity > pharynx (naso-, oro- laryngo-) > larynx > trachea > 1° bronchi > 2° bronchi > 3° bronchi > bronchioles > terminal bronchioles > respiratory bronchioles > alveolar duct > alveolar sac > alveoli (end).

There are 2 Zones of this tract

The Respiratory Tract is divided into:

- Conducting Zone
- Respiratory Zone

“Respiratory Epithelium”

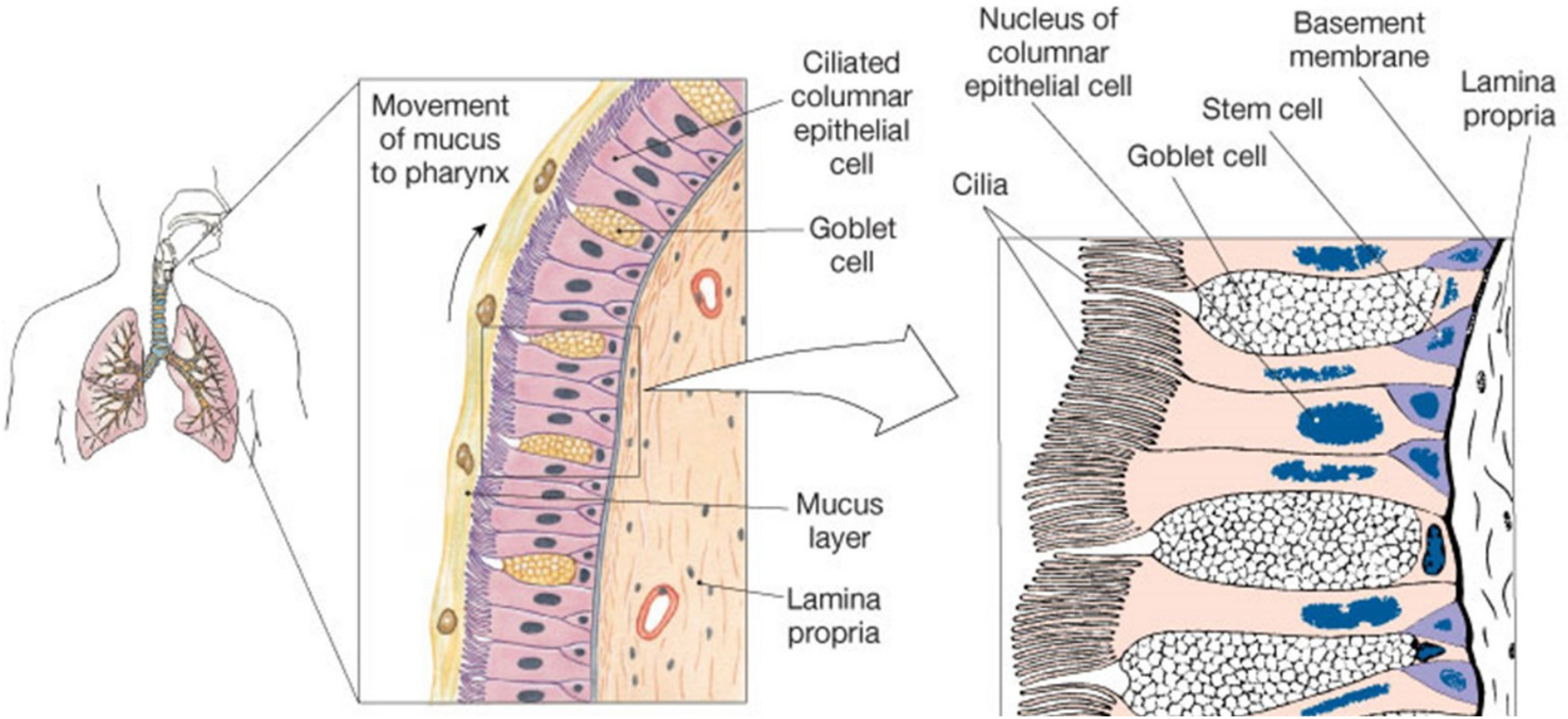
- Lines conducting portions of tract.
- Pseudostratified ciliated columnar epithelium

  (with goblet cells)

  – Produces mucus to trap foreign particles
- Lamina propria is the connective tissue layer

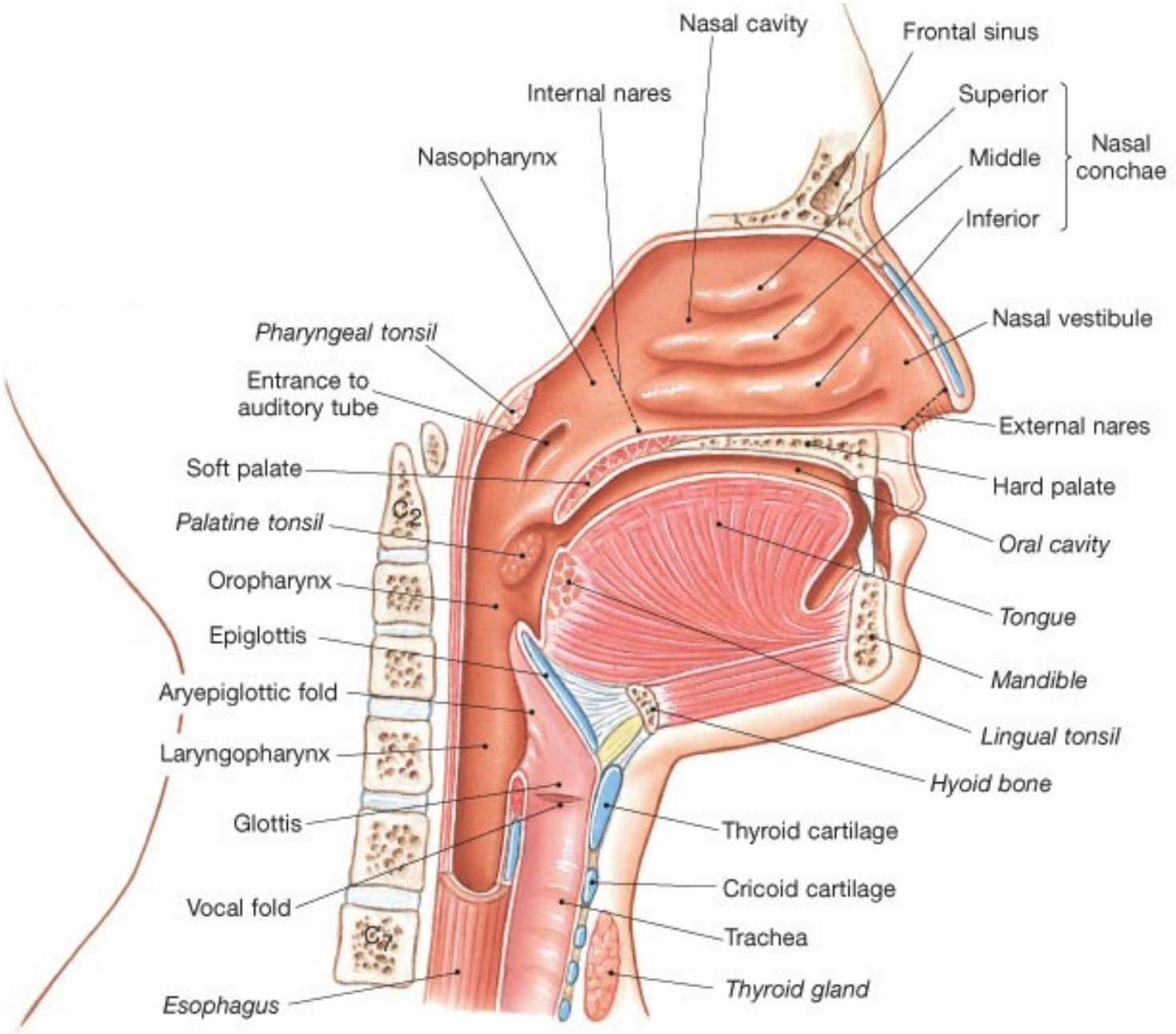
  (Epithelium and lamina propria = mucus membrane)

Respiratory Epithelium



The Journey of Air

- External nares
  - Entrance into vestibule guarded by hairs
- Nasal cavity
  - Superior, middle and inferior meatuses
    - Narrow grooves and conchal surfaces
- Hard palate
  - Divides nasal and oral cavities
- Soft palate
  - Superior nasopharynx and pharynx
- Internal nares
  - Between nasal cavity and nasopharynx



(d) Sagittal section

The Pharynx – 3 Parts

1. Nasopharynx

- Superior to food entry - air only
- Closed off during swallowing

- Pharyngeal tonsil (adenoids)
  - Located on posterior wall
- Opening to the auditory tube

2. Oropharynx

- From soft palate to the epiglottis
- Stratified squamous epithelium

- Two types of tonsils in oropharynx

Palatine tonsils – in the lateral walls of fauces.

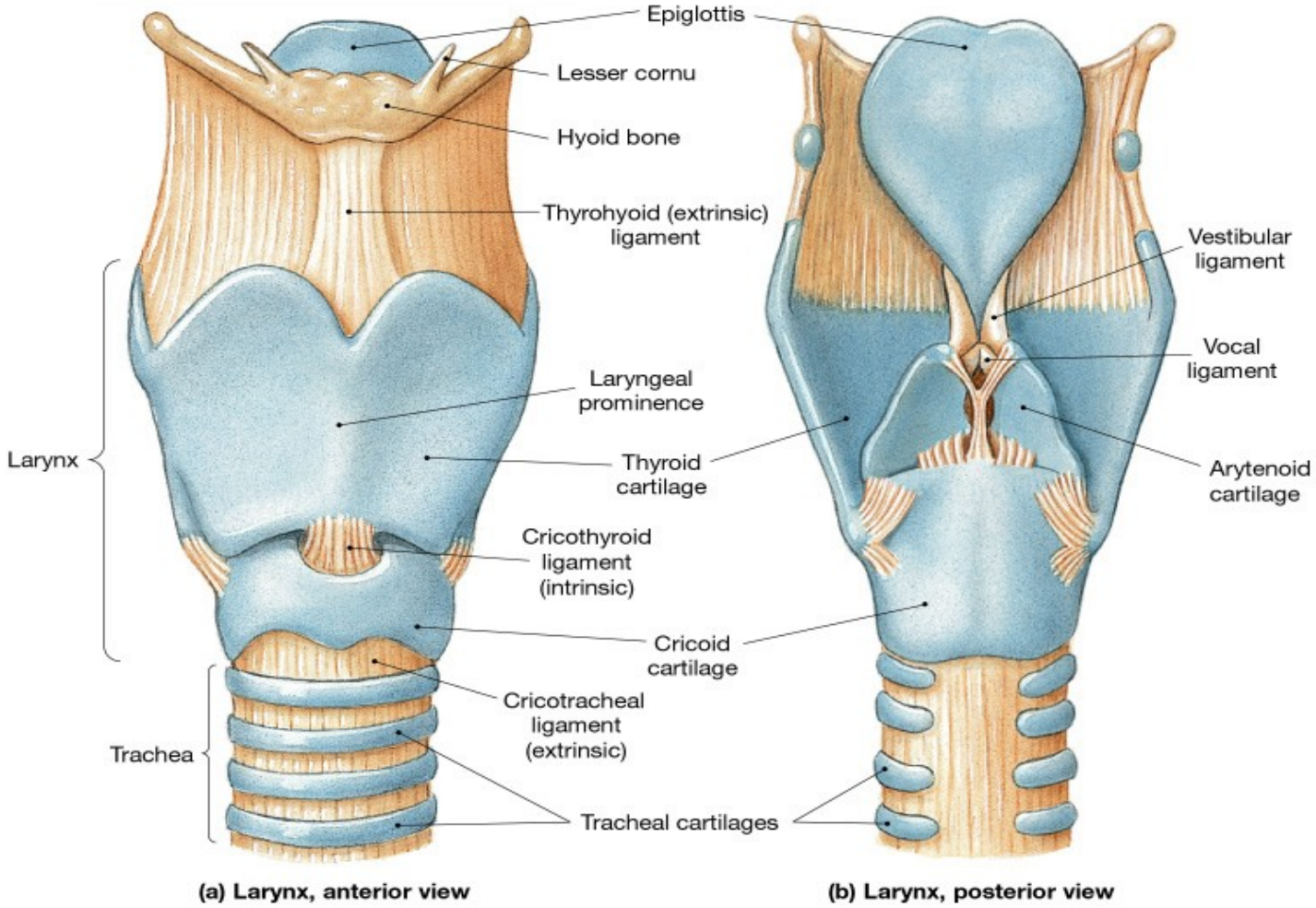
Lingual tonsils – covers posterior surface of tongue

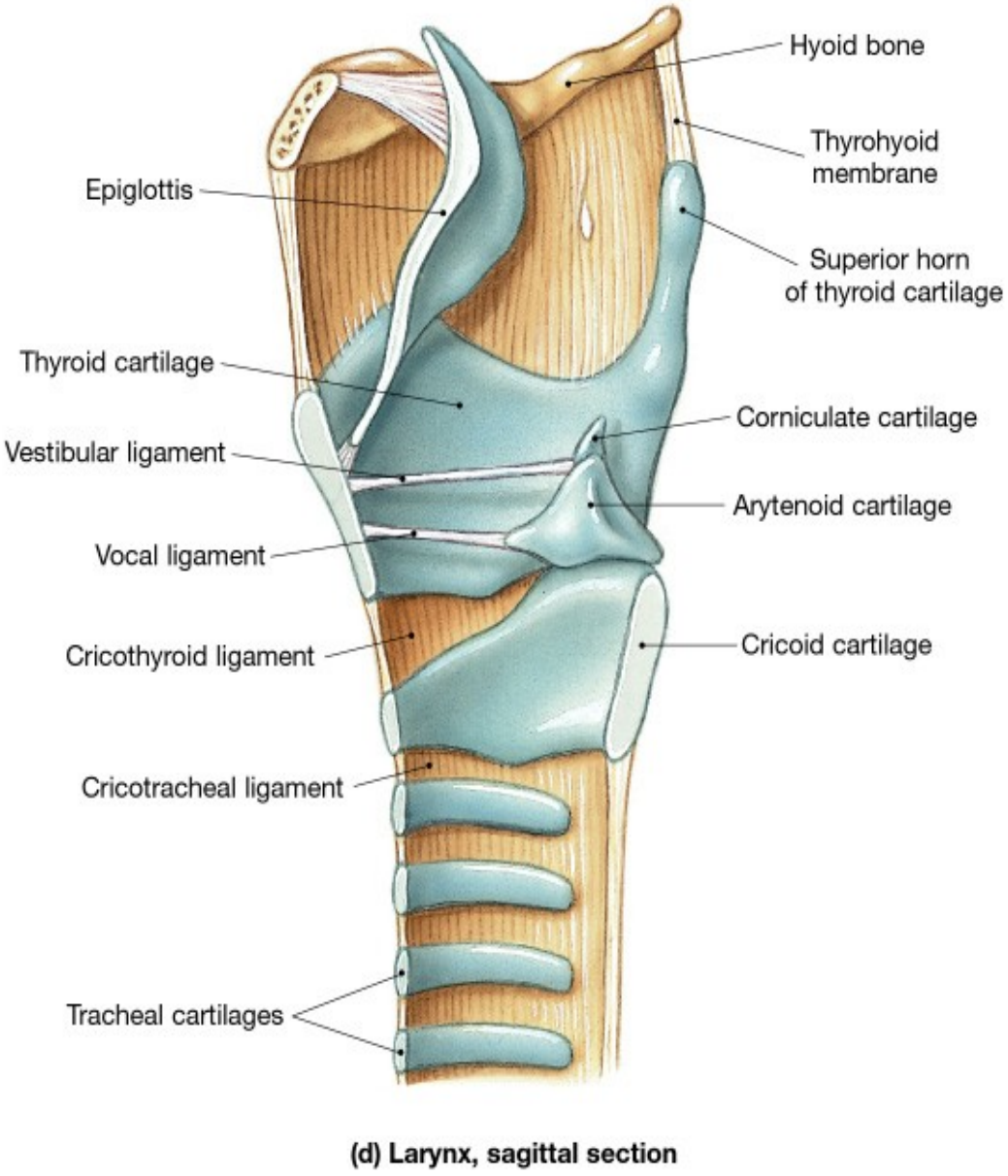
3. Laryngopharynx

- Shared respiratory and digestive passageway
- Stratified squamous epithelium
- Continuous with the esophagus and larynx

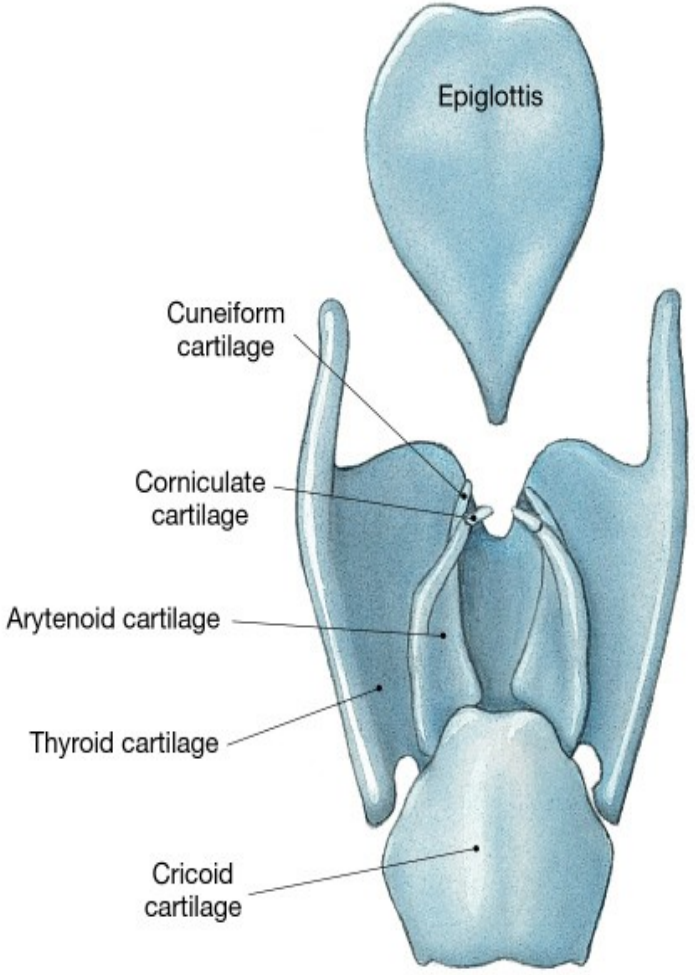
The Larynx

- Surrounds glottis - air passes through glottis to reach lungs
- Epiglottis - prevents solids from entering respiratory system





(d) Larynx, sagittal section



(c) Posterior view of laryngeal cartilages

Elevation of larynx folds epiglottis over glottis when swallowing.

Trachea

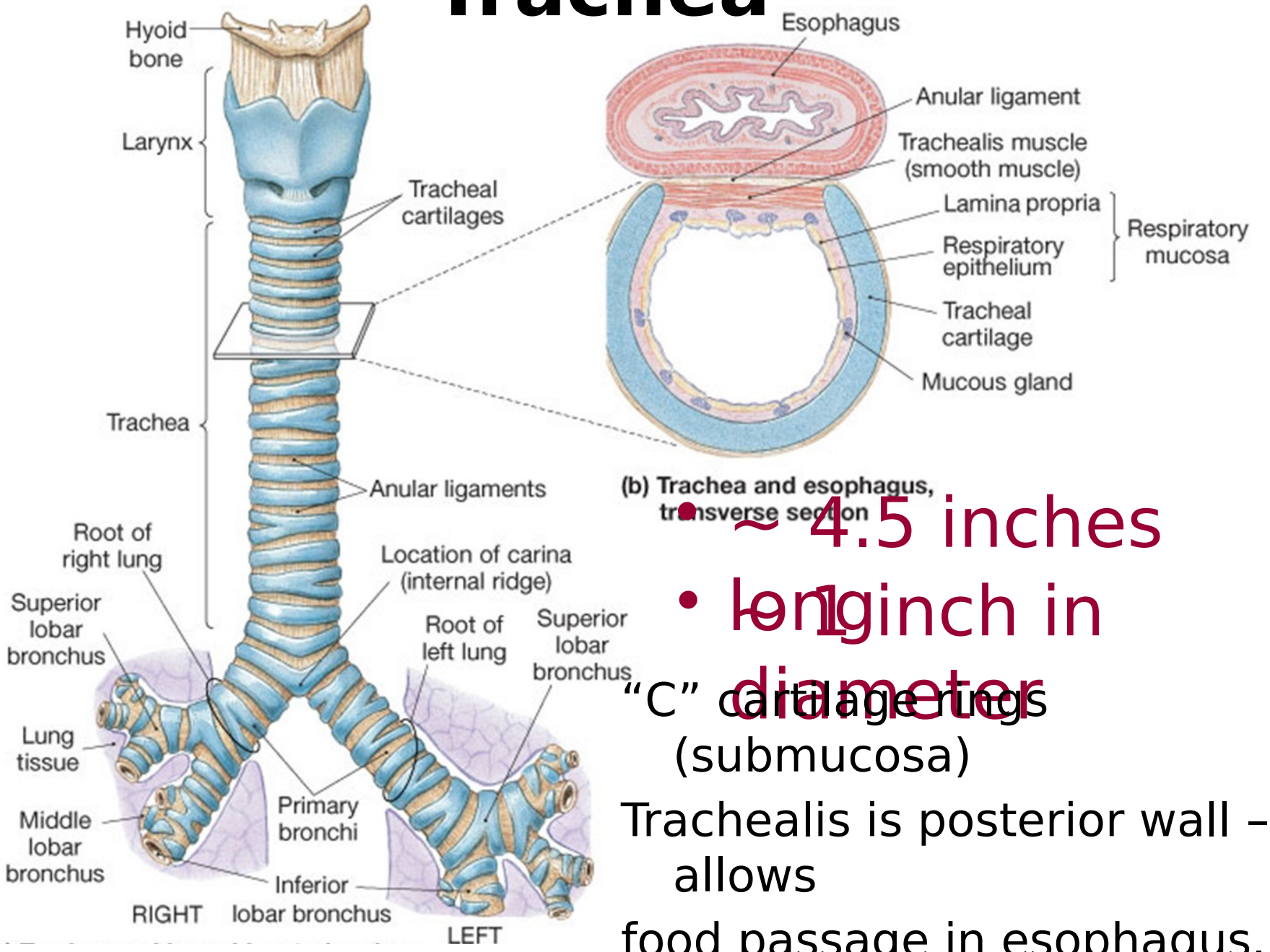
- About 4.5 inches in length.
- About 1 inch in diameter.

Submucosa has “C” rings of cartilage

Posterior wall created by the **trachealis** (smooth muscle),

this distorts to allow food passage in esophagus.

Trachea



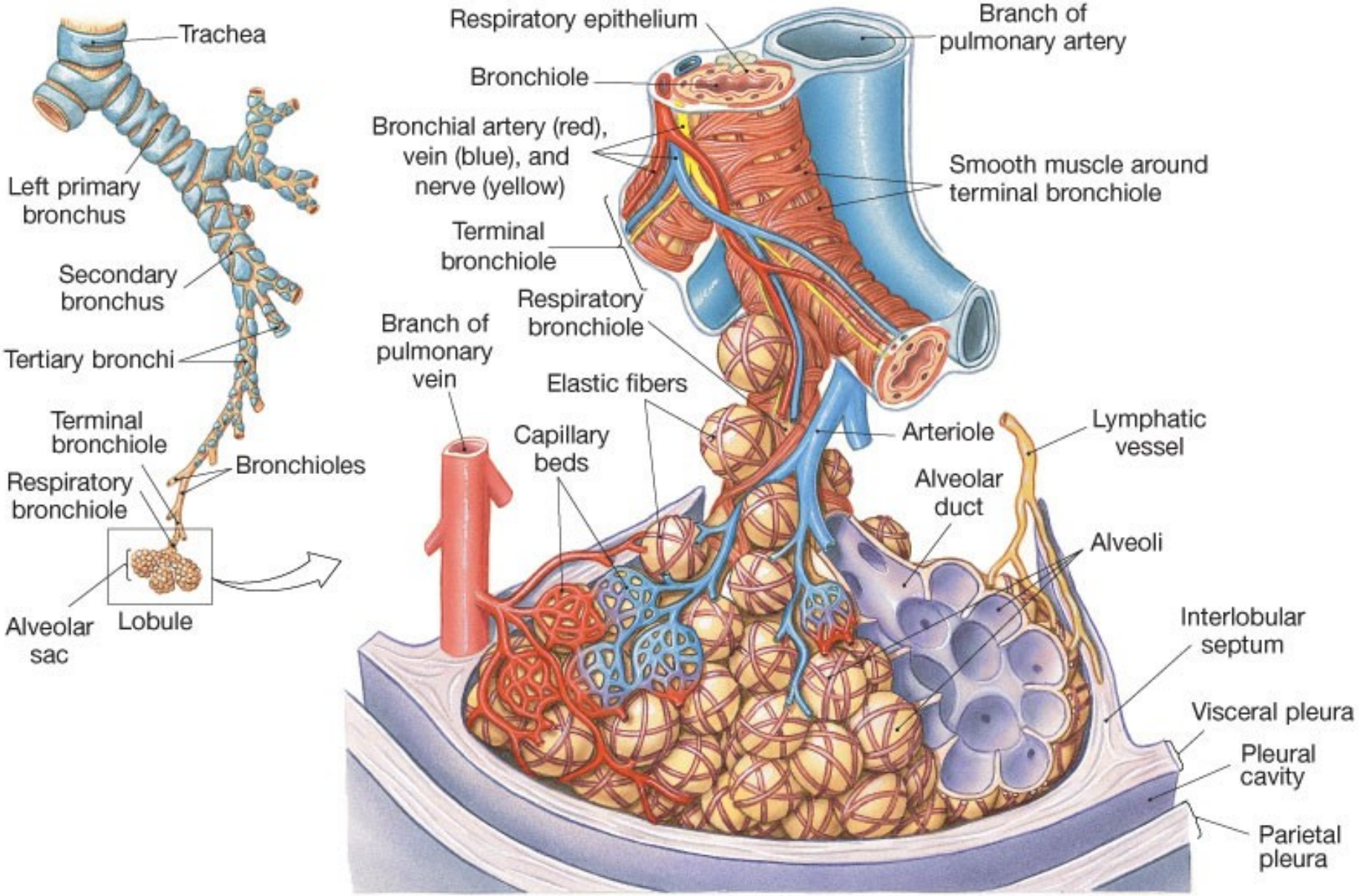
- ≈ 4.5 inches long
- 1 inch in diameter

"C" cartilage rings (submucosa)

Trachealis is posterior wall – allows

food passage in esophagus.

Bronchi and Bronchioles



Bronchioles

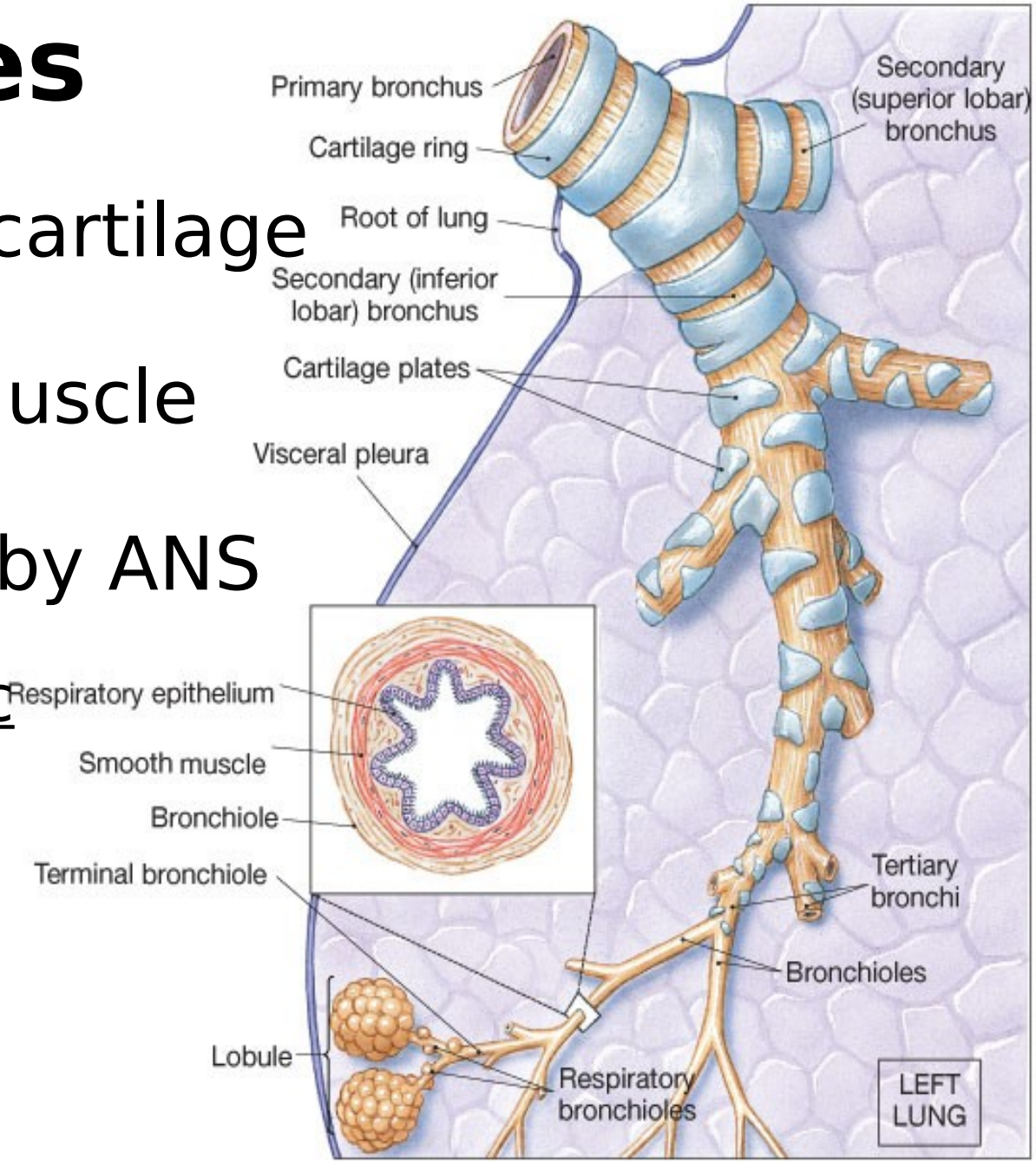
Do not contain cartilage

Have smooth muscle

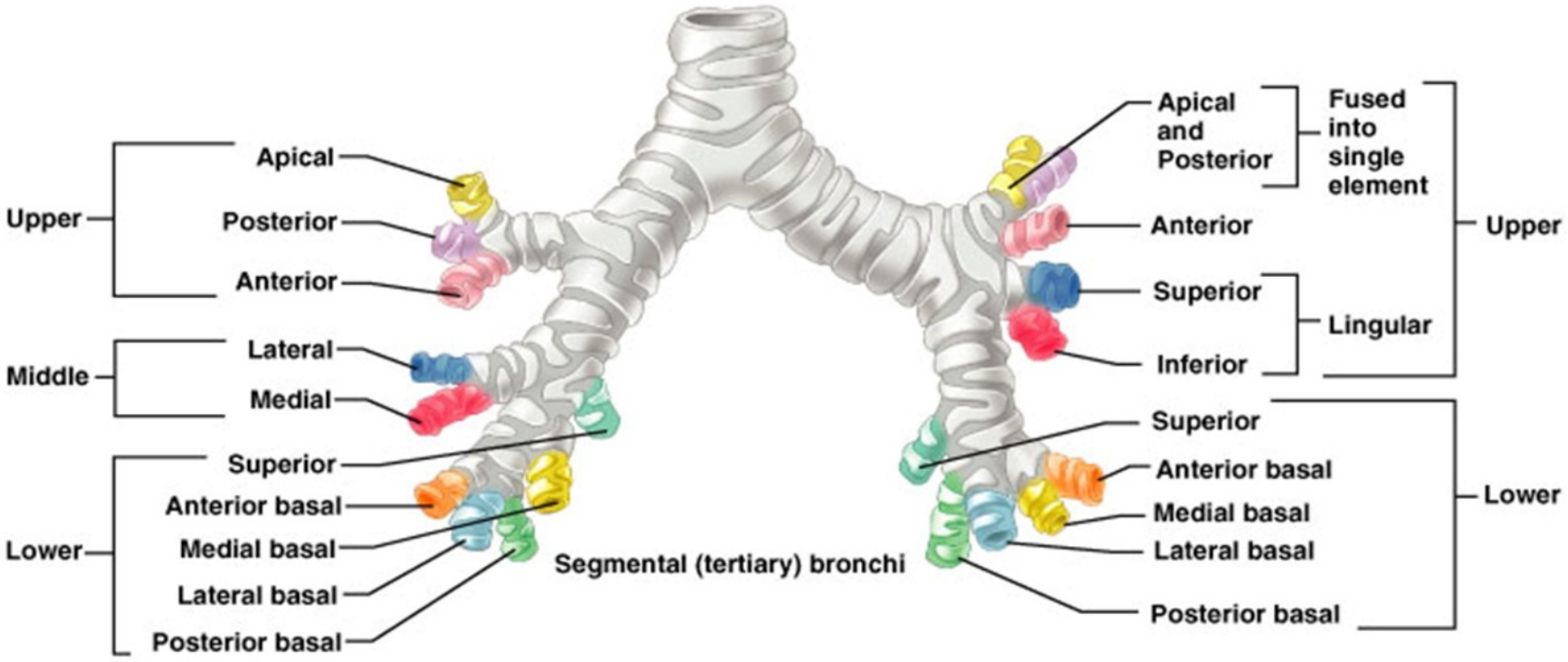
Are Innervated by ANS

<u>Parasympathetic</u>
– constrict airways

<u>Sympathetic</u>
– dilate airways

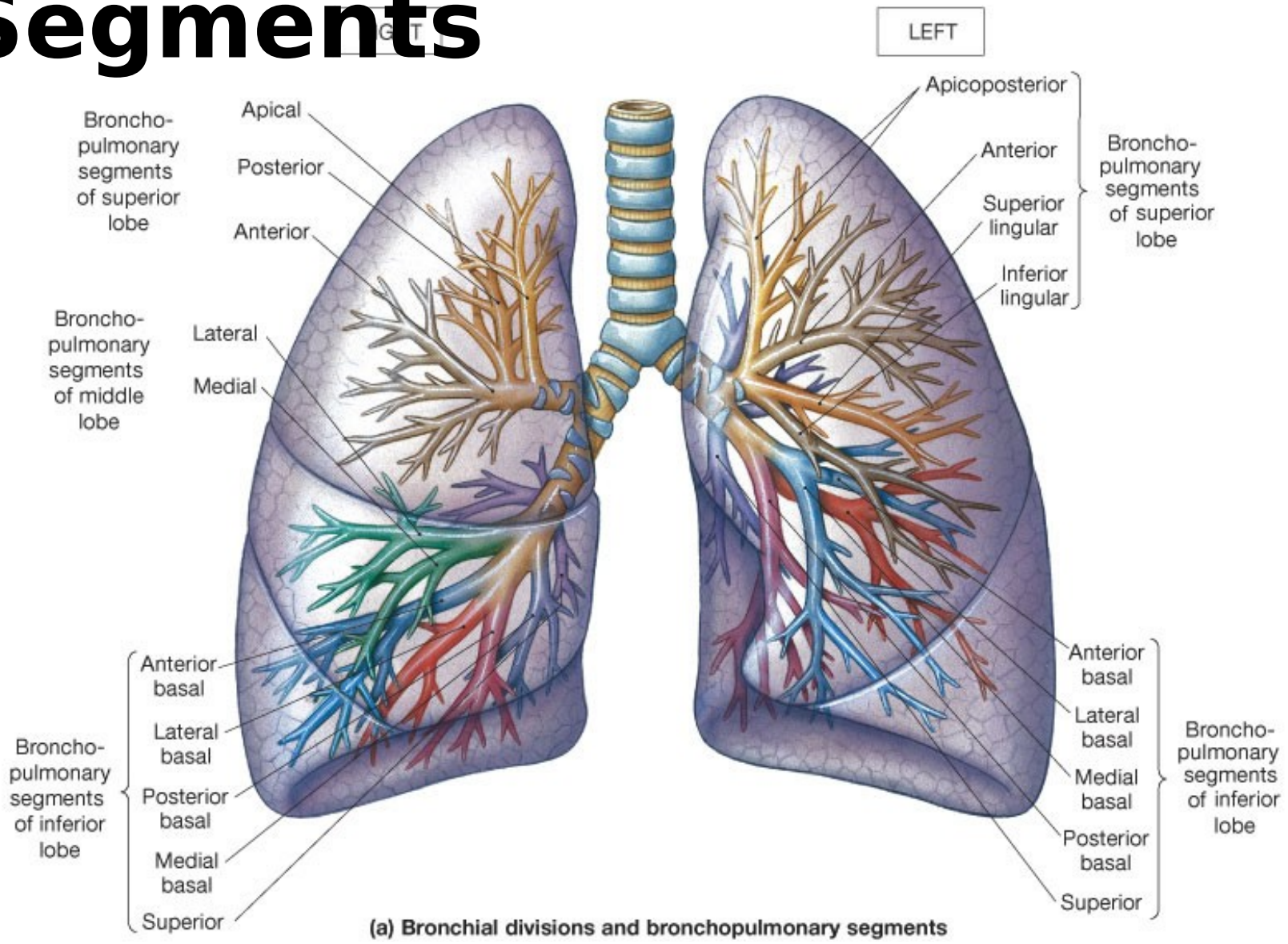


The Bronchiole Tree



Right Lung Left Lung

Bronchopulmonary Segments



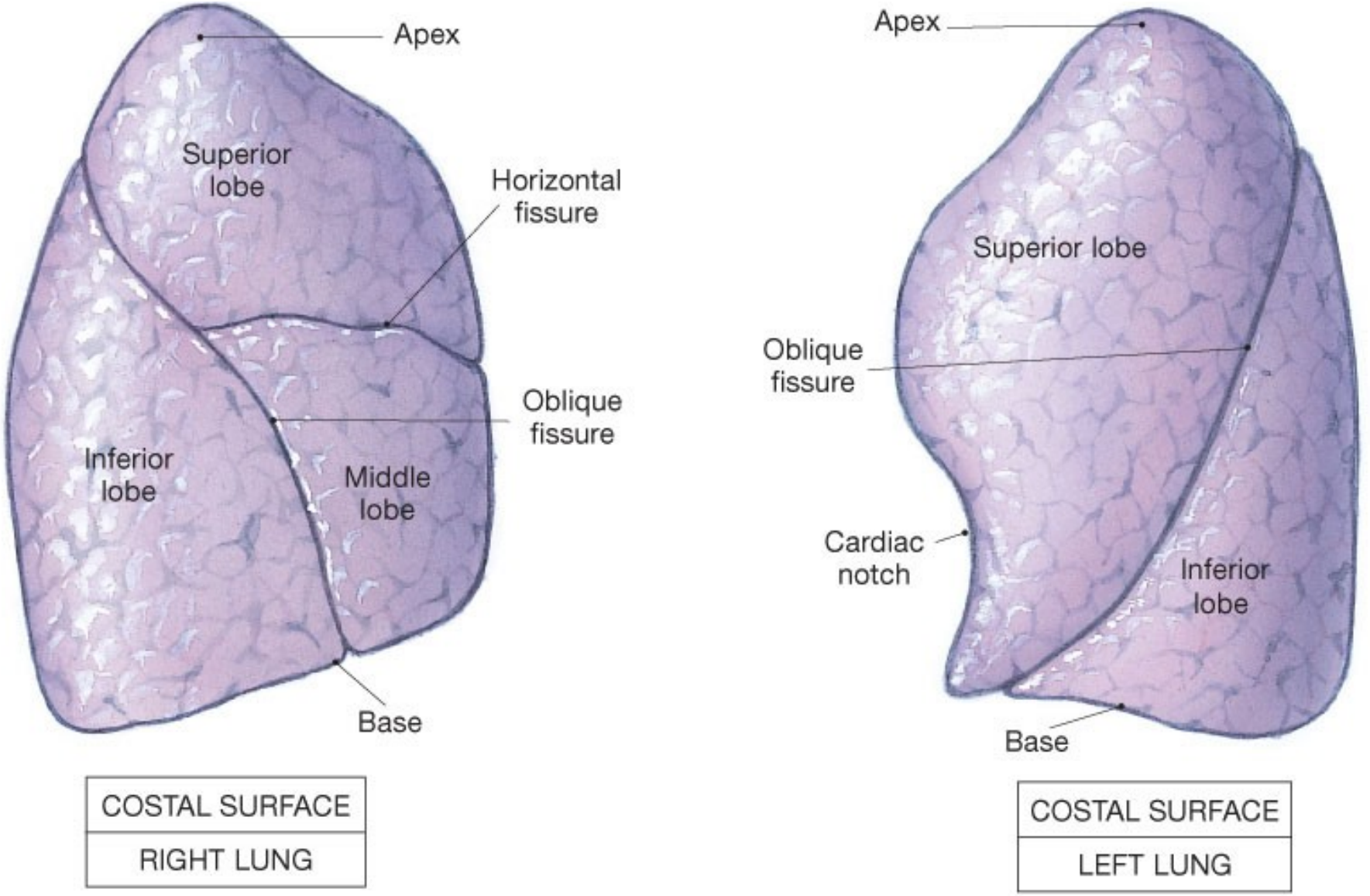
(a) Bronchial divisions and bronchopulmonary segments

The Lungs

- Separated by fissures
  - Right lung has three lobes.
  - Left lung has two lobes.
- Costal surface
  - Anterior surface
  - Follows inner contours of rib cage
- Mediastinal surface
  - Contains hilus
    - Costal notch - Left lung

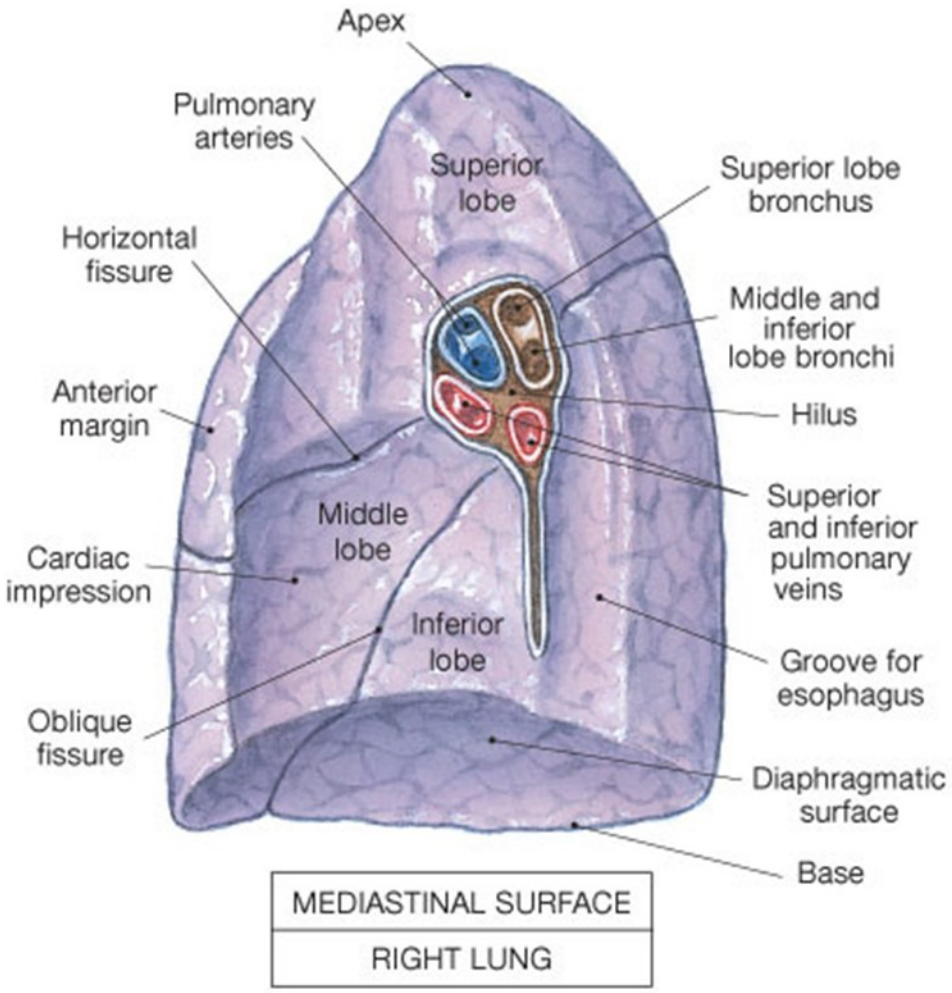
Right Lung

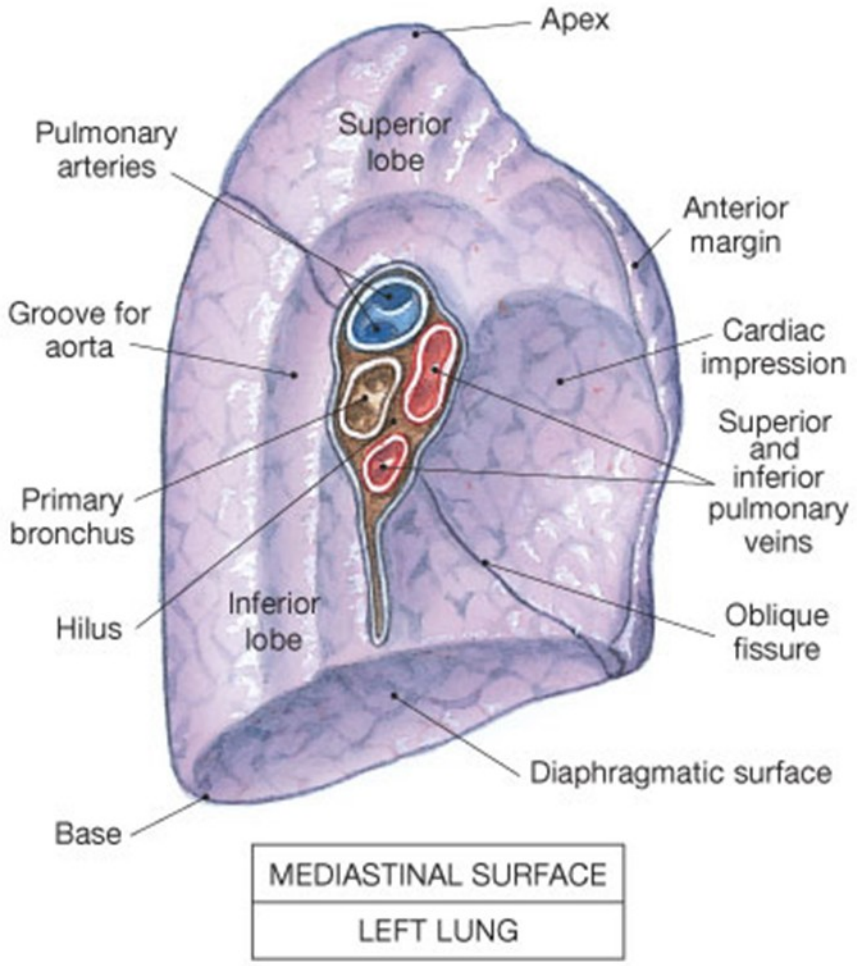
Left Lung



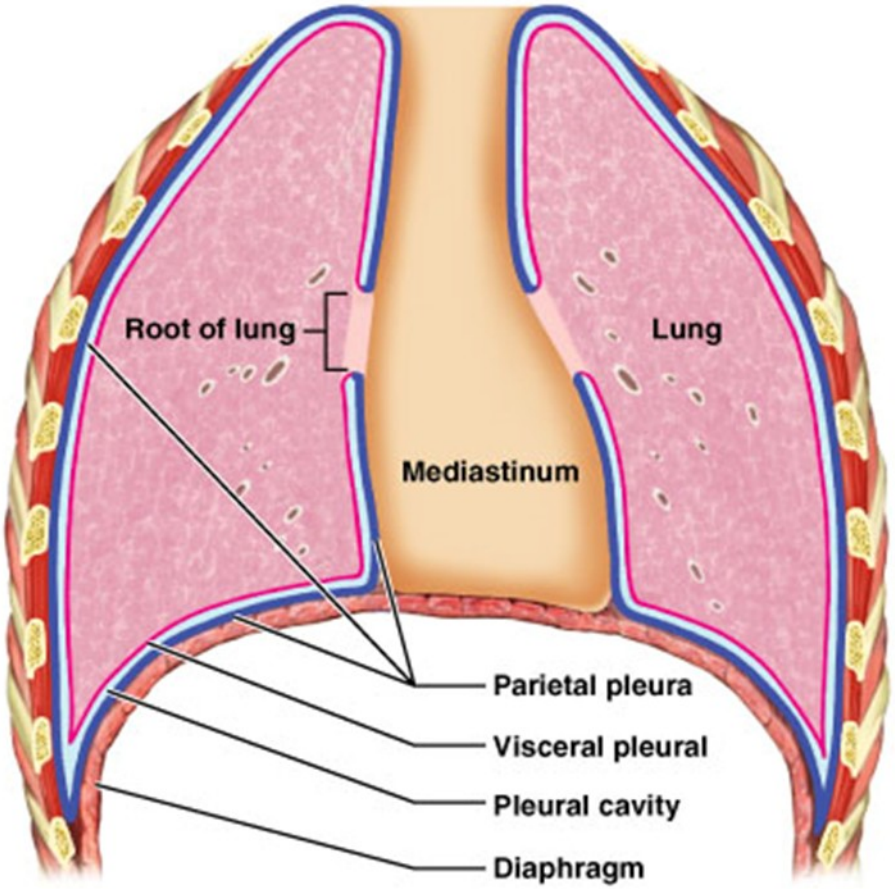
(b) The left and right lungs

Medial aspect of each Lung

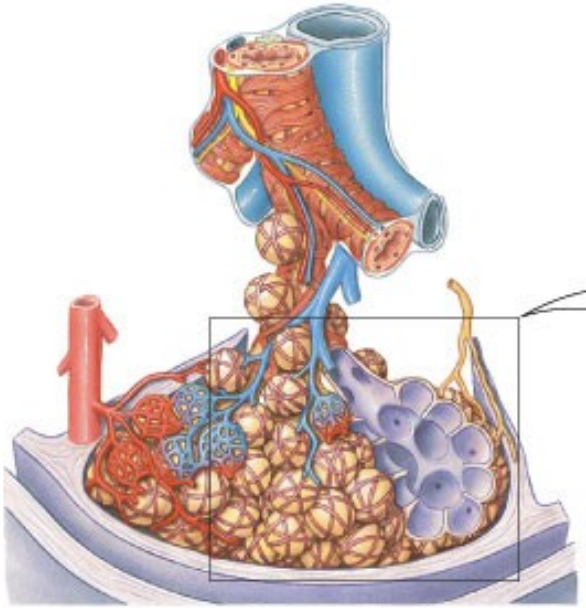




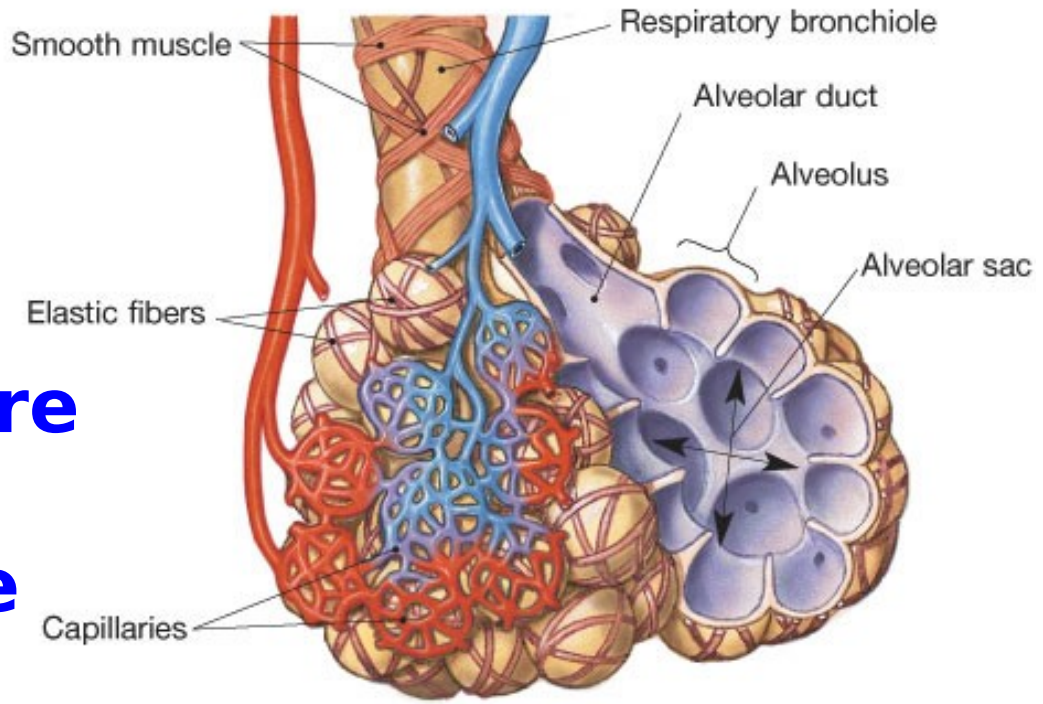
Each Lung is in a ‘Bag’



Visceral pleura
Parietal pleura



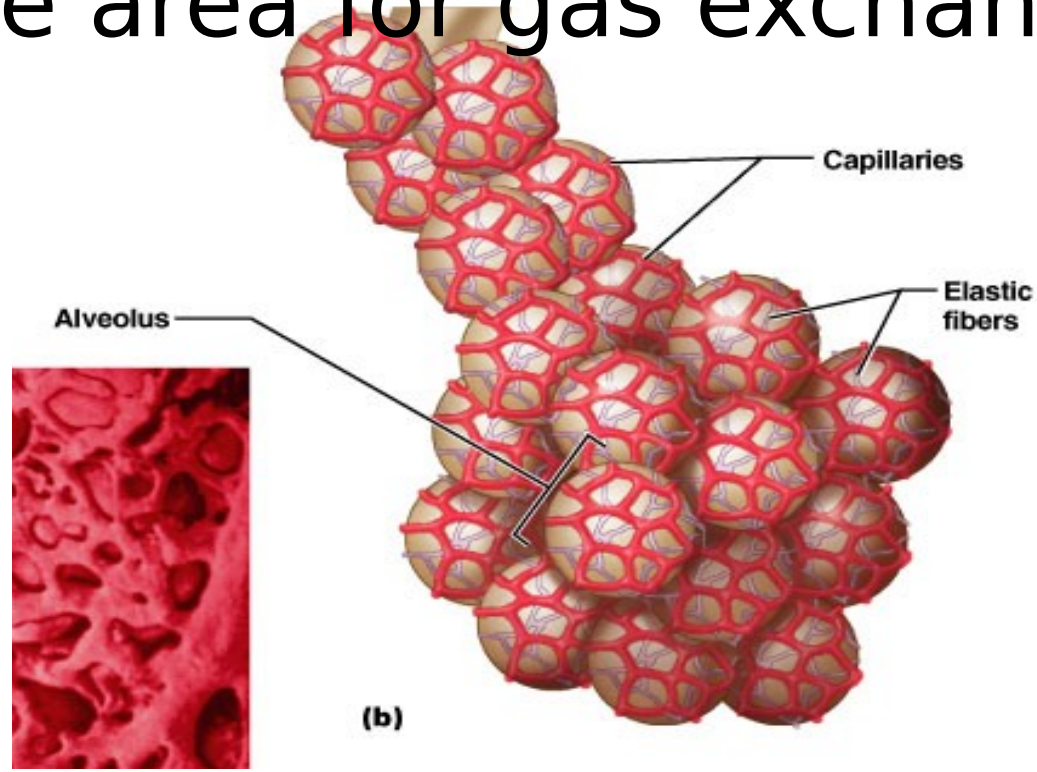
There are about 150 million alveoli in each Lung

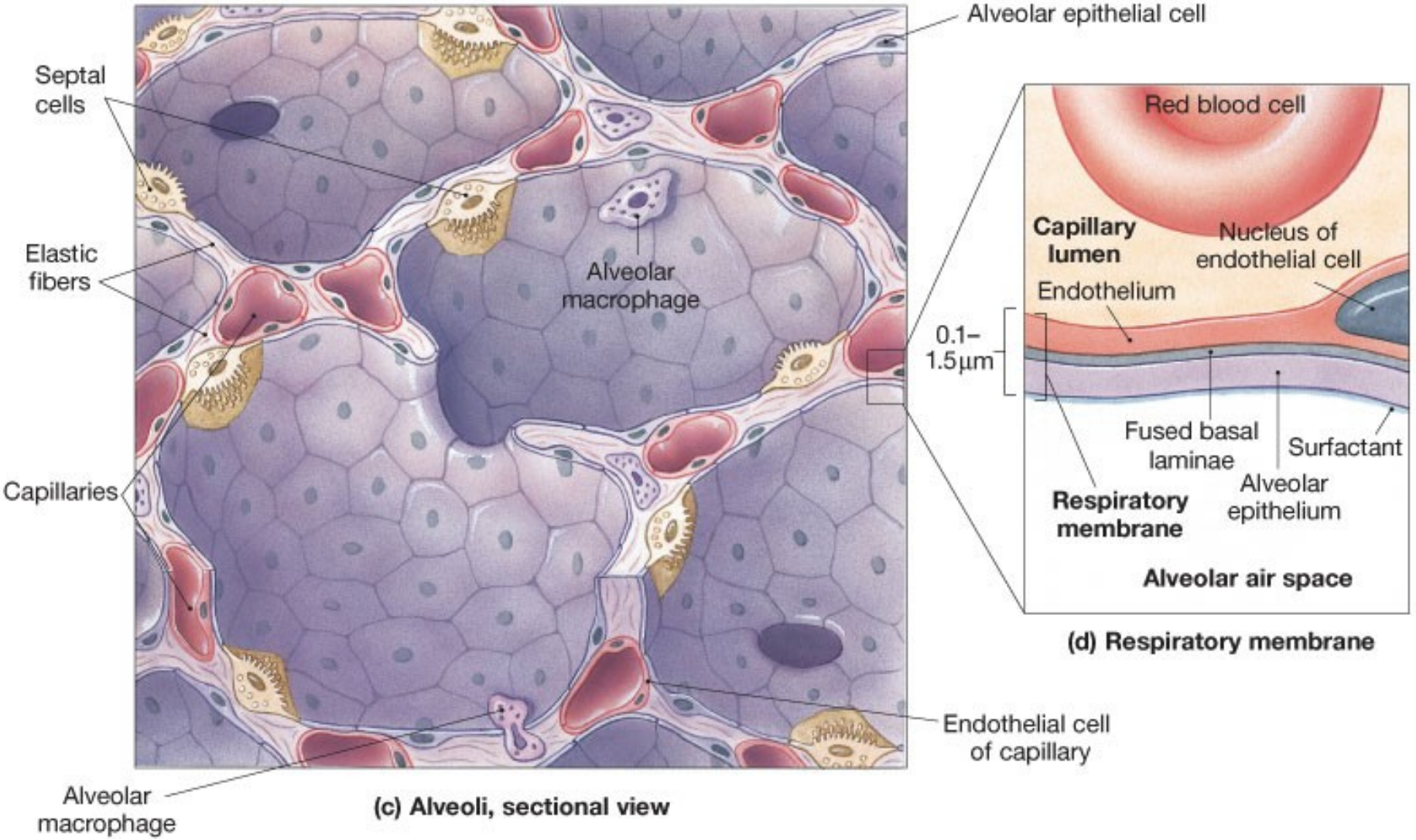


The alveoli is where gas exchange occurs with the pulmonary capillaries

An alveolus consist of 3 Types of cells

1) Alveolar Type I cells – thin (simple squamous epithelium); makes ‘walls’ of alveoli, provides surface area for gas exchange.




Alveolar epithelial cell
Septal cells
Elastic fibers
Capillaries
Alveolar macrophage
Endothelial cell of capillary
Alveolar macrophage
(c) Alveoli, sectional view
Red blood cell
Capillary lumen
Nucleus of endothelial cell
Endothelium
0.1–1.5 µm
Fused basal laminae
Surfactant
Respiratory membrane
Alveolar epithelium
Alveolar air space
(d) Respiratory membrane

2) Alveolar Type II cells release surfactant, makes lungs more Compliant. ('septal' cells).

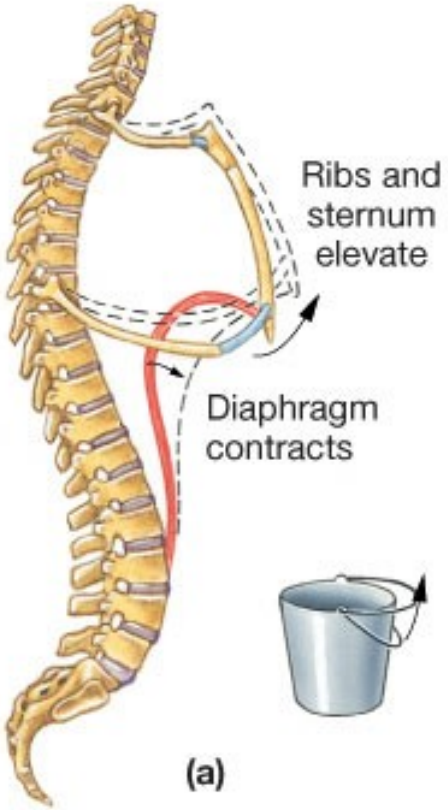
3) Alveolar Macrophages – for protection of alveolar surface. Release trypsin – an enzyme that degrades proteins.

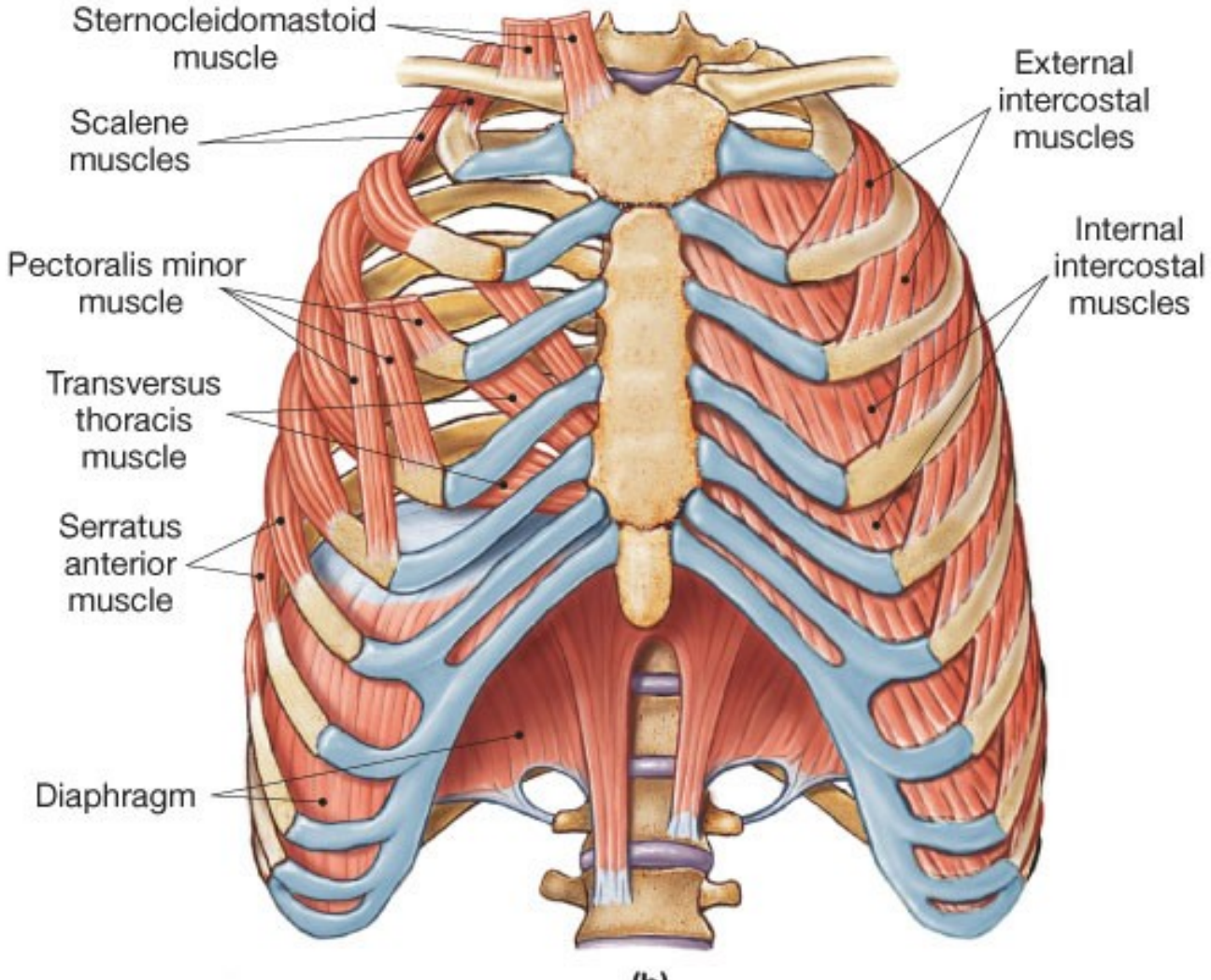
Alveoli also contain Elastic fibers

Elastic Recoil - Push air out (assists ventilation).

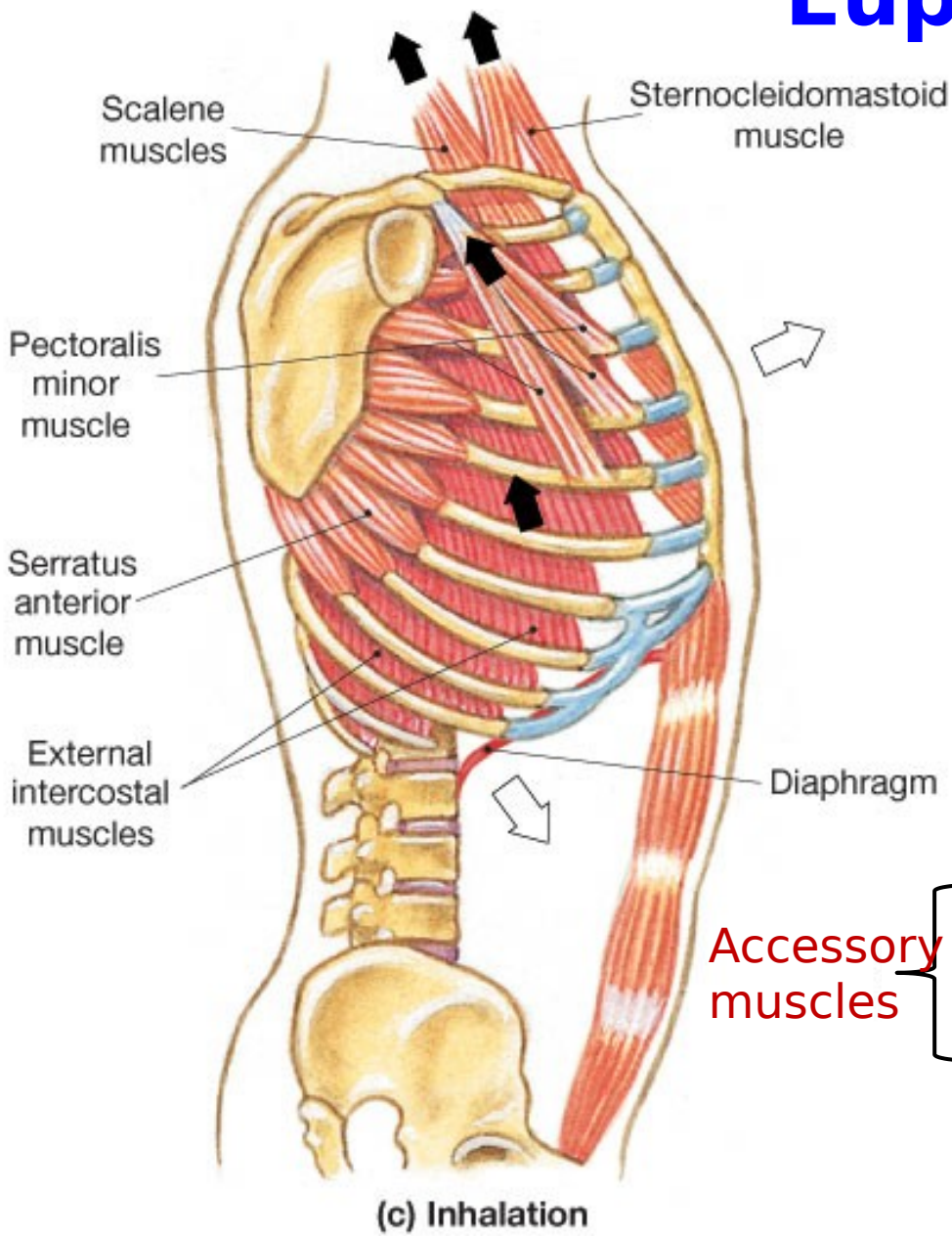
Capillaries cover 90% of surface

Respiratory Muscles





Ventilation - movement of air into and out of lungs.



Eupnea = normal quite breathing at rest.

For Inspiration

Muscle activity required:

Diaphragm

External Intercostals

Accessory muscles:

Sternocleidomastoid

Scalenes

Expiration in Eupnea:

No Muscular activity required!

Restful Breathing ~ **10%** Basal Metabolic Rate (BMR) normally

What is Emphysema?

With emphysema this increases to ____ %

Forceful breathing (hypereupnea):

Same muscles required as in Eupnea.

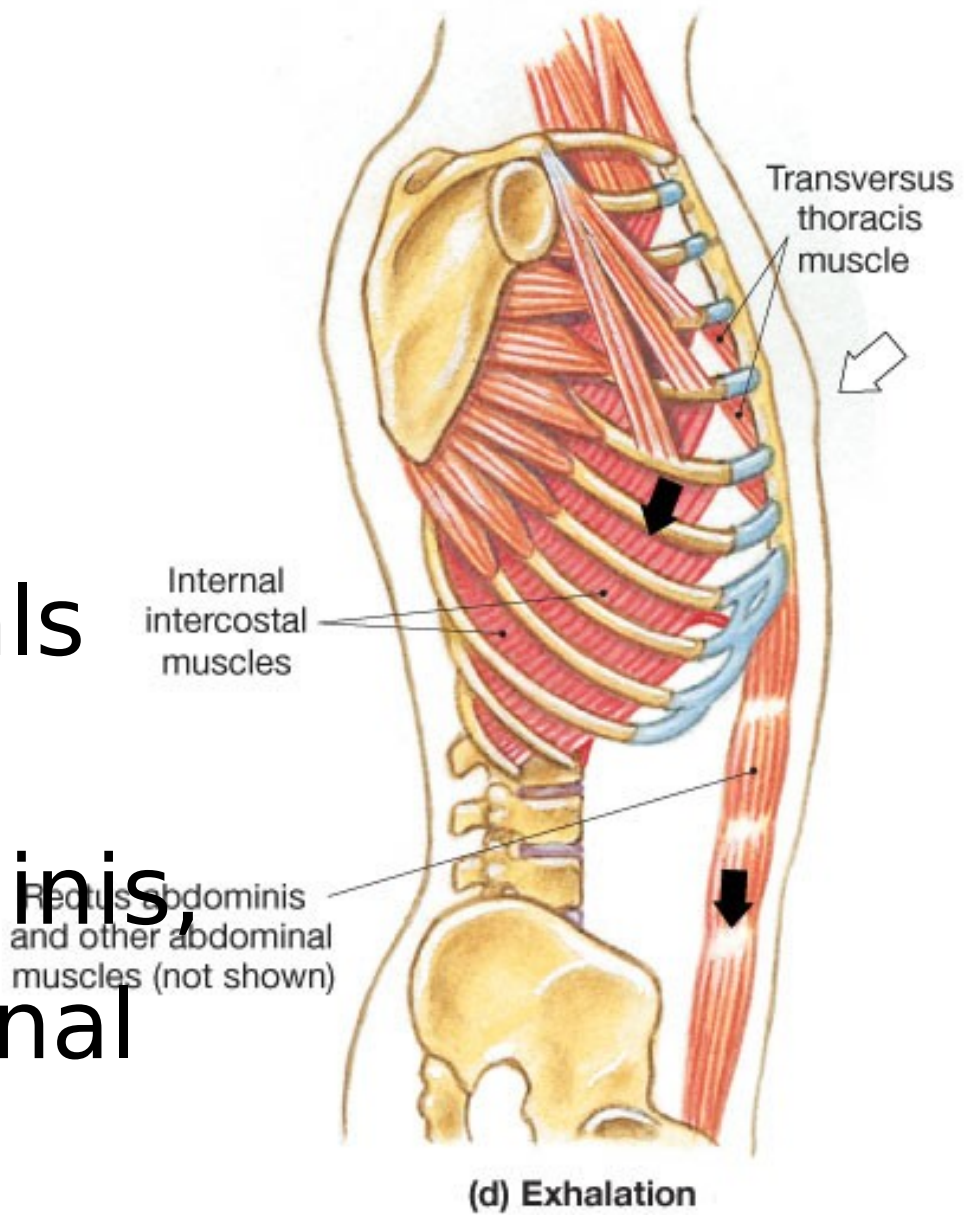
Expiration requires:

Internal Intercostals

Rectus abdominis

Transverse abdominis,

Internal and External obliques.


Transversus thoracis muscle
Internal intercostal muscles
Rectus abdominis and other abdominal muscles (not shown)
(d) Exhalation

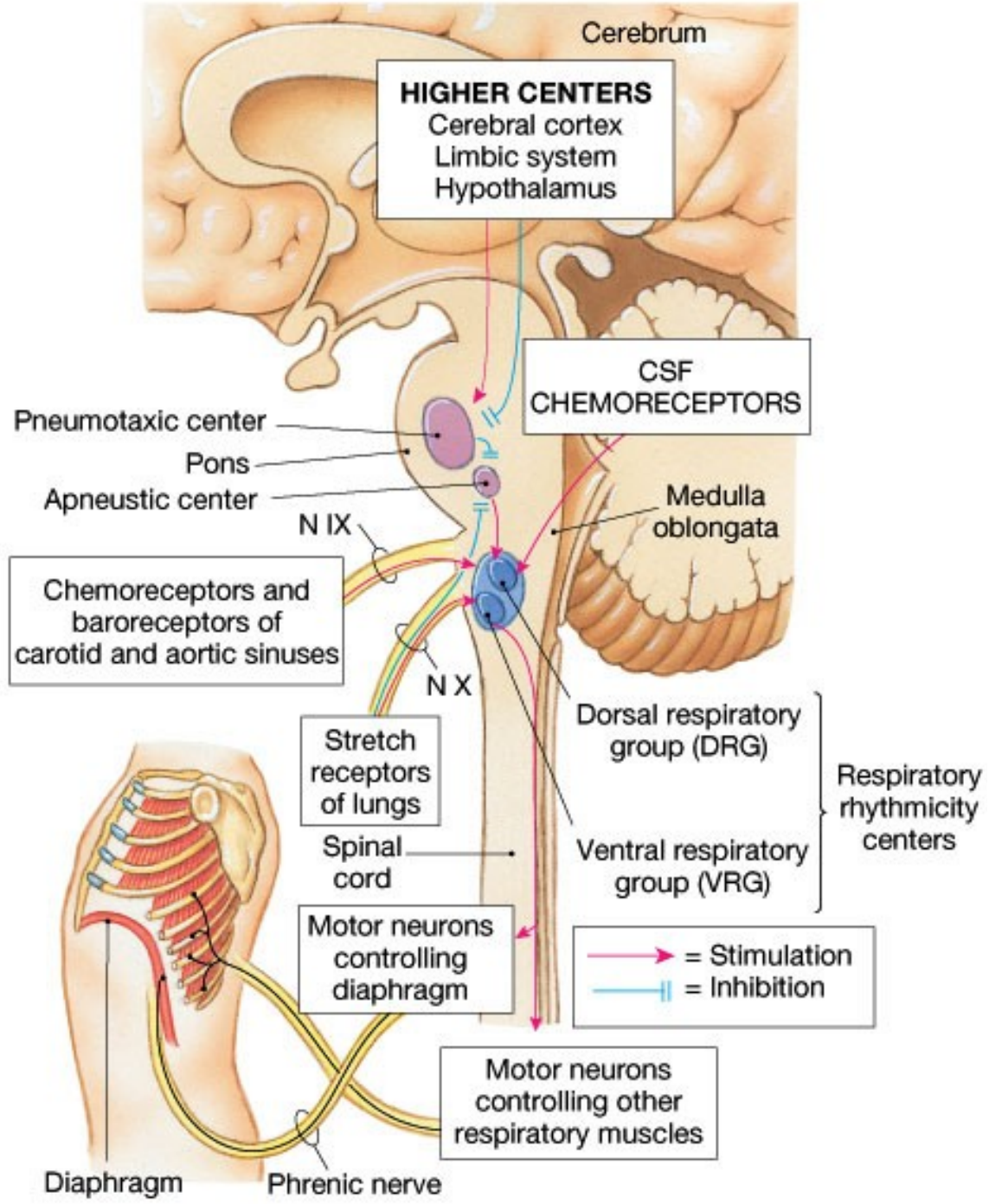
Three pairs of nuclei in *reticular formation* of medulla oblongata and pons

Respiratory rhythmicity center - Sets respiratory pace. Located in the **medulla oblongata**. Doral Resp Group (DRG)

Apneustic center - Strong, sustained inspiratory movements, used for ‘overdrive’ when breathing deep. **Pons**

Pneumotaxic center - Inhibits apneustic and inspiratory centers, sets limits to over inflation of lung.
Pons

Locations of these centers in the brain



ensory Receptors - regulate respiration

Mechanoreceptors

detect changes in lung volume or arterial blood pressure

Chemoreceptors

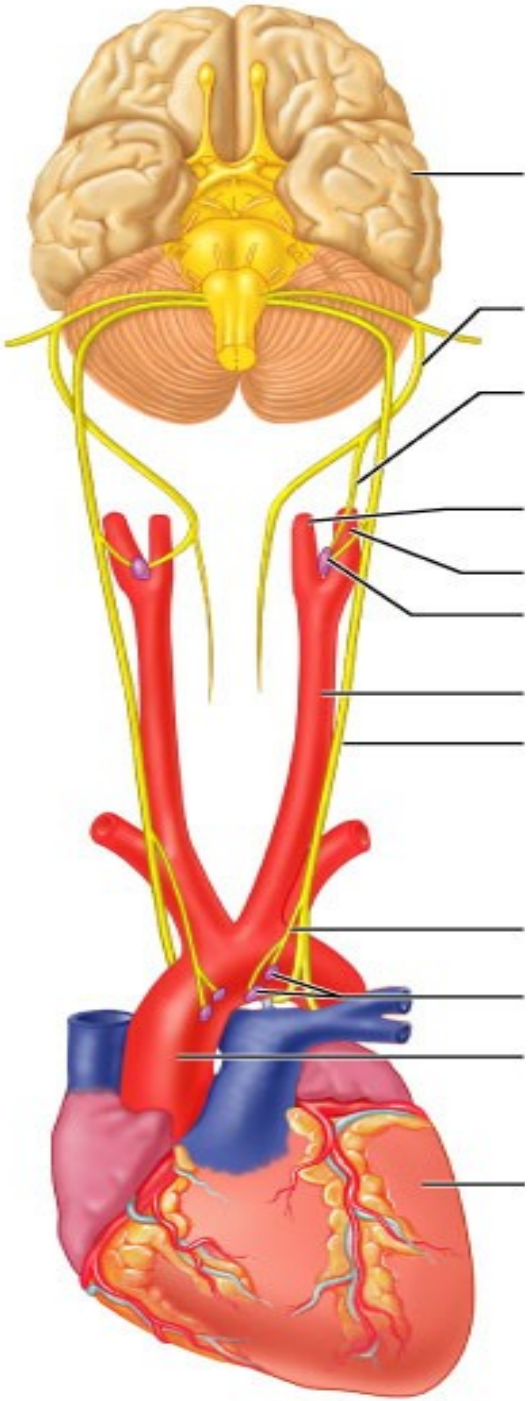
Changes in P_{CO2}, pH, P_{O2} of blood and CSF

Central chemoreceptors - in medulla

Peripheral chemoreceptors

1) Aortic bodies (in aortic arch)

2) Carotid bodies (in carotid sinus)



The major **respiratory centers** are in the **MO** and **Pons**.

There are other important factors that influence respiratory control found in the ***higher centers*** of the brain.